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I, the undersigned, who have prepared English translation which is attached herewith, hereby declare that the aforementioned translation is true and correct translation of officially certified copy of the Korean Patent Application No. 2003-31838 filed on May 20,2003.

This 10th day of October, 2005

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[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

A plurality of spacers is formed on a panel for a liquid crystal display for supporting the panel. The spacers have at least two different heights or at least two different contact areas with the panel. The spacers include a plurality of first spacers and a plurality of second spacers having a height lower than the first spacers and having a contact area wider than the first spacers. The height difference between the first spacers and the second spacers is preferably in a range of about 0.3-0.6 microns, and the second spacers have a length larger than the first spacers preferably by 10-20 microns. Since the first spacers exhibit small compression deformation and are advantageous for dispersing the stress, they are capable of keeping a cell gap between the two panels uniform. On the contrary, since the second spacers exhibit large compression deformation, they facilitate to adjust an amount of LC for forming the liquid crystal layer and prevent light leakage phenomenon.

[REPRESENTATIVE FIGURE]

Fig. 13

[INDEX]

liquid crystal, spacer, liquid crystal panel, liquid crystal cell gap

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[SPECIFICATION]

[TITLE OF THE INVENTION]

PANELS FOR LIQUID CRYSTAL DISPLAYS, A METHOD FOR MANUFACTURING THE SAME AND LIQUID CRYSTAL DISPLAY INCLUDING THE SAME

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a plan view of a panel assembly for a display device according to a first embodiment of the present invention;

Fig. 2 is a sectional view of the panel assembly shown in Fig. 1 taken along the line II-II';

Fig. 3 is a sectional view of a panel and a plurality of column spacers formed thereon for the display device according to the first embodiment of the present invention;

Figs. 4A and 4B are sectional views of a panel assembly for the display device in intermediate steps of a manufacturing method thereof according to the first embodiment of the present invention;

Figs. 5A and 5B are sectional views of a panel assembly for the display device in intermediate steps of a manufacturing method thereof according to a second embodiment of the present invention;

Fig. 6 is a sectional view of a panel assembly for the display device in an intermediate step of a manufacturing method thereof according to a third embodiment of the present invention;

Fig. 7 is a layout view of an LCD according to the first embodiment of the present invention;

Fig. 8 is a sectional view of the LCD shown in Fig. 7 taken along the line VIII-VIII';

Fig. 9 is a sectional view of an LCD according to the second embodiment of the present invention;

Fig. 10 shows exemplary locations of the spacers in the display device according to the first embodiment of the present invention;

Fig. 11 is a plan view of a panel assembly for an LCD according to a fourth embodiment of the present invention;

Fig. 12 is a sectional view of the panel assembly shown in Figs. 11 taken along the line XII-XII';

Fig. 13 is a sectional view of a panel and a plurality of column spacers formed thereon for the LCD according to the fourth embodiment of the present invention;

Fig. 14 shows exemplary locations of the spacers according to the fourth embodiment of the present invention;

Fig. 15 is a layout view of an LCD according to the fourth embodiment of the present invention;

Figs. 16 and 17 are sectional views of the LCD shown in Fig. 16 taken along the line XVI-XVI' and the line XVII-XVII', respectively;

Fig. 18 is a sectional view of a LC panel assembly in an intermediate step of a manufacturing method thereof according to the fifth embodiment of the present invention; and

Fig. 19 is a sectional view of a LC panel assembly in an intermediate step of a manufacturing method thereof according to a fifth embodiment of the present invention.

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND CONVENTIONAL ART IN THE FIELD]

The present invention relates to a panel for a liquid crystal display and a method for manufacturing the same, and in particular, to the liquid crystal display and the method for manufacturing the same including spacers.

Generally, a liquid crystal display (LCD) includes two panels including field-generating electrodes and coated with alignment layers and a liquid crystal (LC) layer having dielectric anisotropy and filled in a gap (called a cell gap) between the panels. Electric fields are applied to the LC layer by using field-generating electrodes and the transmittance of light passing through the panels are controlled by adjusting the field strength, thereby displaying desired picture images.

The two panels are assembled by printing a sealant along a periphery of one of the panels and by hot-pressing the panels.

The cell gap between the panels is supported by elastic spacers provided between the panels and the sealant also includes spacers for maintaining the cell gap. The LC layer is encapsulated by the sealant. The spacers include spherical spacers spread on the panels and columnar spacers formed by photolithography.

It becomes important to keep the cell gap uniform and to facilitate the formation of the LC layer as the LCD becomes large.

[TECHNICAL TASK OF THE INVENTION]

It is a motivation of the present invention to keep the cell gap uniform and to facilitate the formation of the LC layer.

[CONFIGURATION AND OPERATION OF THE INVENTION]

A panel assembly for a display device is provided, which includes: a panel; and a plurality of spacers formed on the panel for supporting the panel, wherein the spacers have at least two different heights.

The contact areas of the spacers with the panels are circular or tetragonal.

The spacers preferably include a plurality of first spacers and a plurality of second spacers having a height lower than the first spacers. The first and the second spacers may be located on different color filters.

The spacers preferably include a first spacer, a second spacer having a height lower than the first spacer, and a third spacer having a height equal to or lower than the second spacer. The height of the third spacer is preferably equal to the height of the second spacer. The first, the second and the third spacers may be located on different color filters.

The panel may include a gate line and a data line transmitting electrical signals such as scanning signal and image signal, a thin film transistor electrically connected to the gate line and the data line, and a pixel electrode connected to the thin film transistor. Alternatively, the panel may include a plurality of color filters of red, blue and green, which are sequentially formed.

According to an embodiment of the present invention, a method of manufacturing a liquid crystal panel assembly uses exposure mask of one sheet or two sheets to form the spacers having at least two different heights and at least different contact areas.

According to a first embodiment of the present invention, a method of manufacturing a liquid crystal panel assembly is provided, which includes: coating a photoresist on a panel;

light-exposing the photoresist through an exposure mask including an opening and disposed on the panel with a first distance; light-exposing the photoresist through the exposure mask disposed on the panel with a second distance; and developing the photoresist to form first and second spacers having different heights or different contact areas with the panel.

According to another embodiment of the present invention, a method of manufacturing a liquid crystal panel is provided, which includes: coating a photoresist on a panel; light-exposing the photoresist through a first exposure mask including a first opening; light-exposing the photoresist through a second exposure mask including a second opening; and developing the photoresist to form first and second spacers having different heights or different contact areas with the panel.

According to another embodiment of the present invention, a method of manufacturing a liquid crystal panel is provided, which includes: coating a photoresist on a panel; light-exposing the photoresist through an exposure mask including a plurality of transmissive areas having different transmittances and a blocking area; and developing the photoresist to form a plurality of spacers having different heights or different contact areas with the panel.

The photoresist is preferably a negative type.

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. The present invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

In the drawings, the thickness of layers, films and regions are exaggerated for clarity. Like numerals refer to like elements throughout. It will be understood that when an element such as a layer, film, region or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

Now, panels for a liquid crystal display and manufacturing methods thereof according to embodiments of the present invention will be described with reference to the accompanying drawings.

In a method for manufacturing a display device including two panels, hot press process adhering the two panels to the plates, and pressing the two plates to attach two panels to each other, and vacuum compression process making the space enclosed by the sealant and two panels vacuous and exposing two panels to attach two panels to each other using the external atmosphere press are generally provided. Here, a plurality of spacers having the elasticity is arranged between the two panels to support the two panels with uniform interval, and the spacers may be spherical shape or column shape. The spherical spacers are dispersed on the panel and the column spacers are formed on the panel through a photolithography coating and pattering the photoresist. The column spacers may uniformly formed on the panel at the predetermined positions, and may wholly support two panels with uniform interval. Furthermore, the column spacers may uniformly support two panels with thin interval, and prevents the spacers from arranging in the pixel region so the characteristic of the display device is improved. The column spacers are pressed when the spacers supports two panels. However, if the sectional areas of the column spacers supporting the panels is small, and the compression deformation is large, the deformation of the column spacers are easily or the column spacers are breakdown, such that the cell gap between two panels is un-uniform. On the contrary, if the sectional areas of the column spacers supporting the panels is large, and the compression deformation is small, it is difficult to adjust an amount of LC for forming the liquid crystal layer between two panels, such that the bubble is generated are the liquid crystal material is driven in the random position. To solve theses problems, the spacers have at least two different heights or at least two different contact areas with the panel in the present invention.

At first, a panel assembly for LCDs according to an embodiment of the present invention will be now described in detail with reference to the drawings.

Fig. 1 is a plan view of a panel assembly for LCDs according to an embodiment of the present invention and Fig. 2 is a sectional view of the panel assembly shown in Fig. 1 taken along the line II-II'.

As shown in Figs. 1 and 2, a panel assembly 40 according to a first embodiment of the present invention includes two panels 100 and 200 and a plurality of LC layers 3, a plurality of sealants 310, and a plurality of columnar spacers 321 and 322, which are disposed between the two panels 100 and 200.

The panel assembly 40 includes a plurality of, for example, four cell areas divided by dotted lines A and B. The panel assembly 40 is separated into the respective LCDs by scribing the panel assembly 40 along the dotted lines A and B.

Each of the device areas (or an LCD) includes a display area 51, 52, 53 or 54 for displaying images. The display area 51-54 is substantially enclosed by the sealant 310, which confines the LC layer 3. The LC layer 3 may be formed after the panel assembly 400 is separated into the respective devices.

The spacers 321 and 322 are provided for maintaining a gap between the panels 100 and 200 to be uniform and the sealant 310 may contain spacers for supporting the panels 100 and 200 to be parallel to each other.

As shown in Fig. 2, the spacers 321 and 322 contact the panels 100 and 200 with different contact areas and sizes. The different contact areas of the spacers 321 and 322 are obtained by forming spacer columns with different heights and by pressing the spacer columns to have the same height, will be described in detail.

Fig. 3 is a sectional view of a panel and a plurality of column spacers formed thereon for an LCD according to an embodiment of the present invention.

A plurality of column spacers 321 and 322 having different top and/or bottom areas and different heights are formed on a panel 100 for an LCD according to an embodiment of the present invention.

Top and bottom surfaces of the column spacers 321 and 322 have a shape of a circle with a diameter or a tetragon with edges. The diameter or edge (hereinafter referred to as "length") b of the bottom surface of each first spacer 321 is longer than the length c of each second spacer 422. The height difference is preferably about 0.3 to 0.6 microns. It is preferable that the length b of the first spacers 321 ranges from about 30 microns to about 35 microns while the length c of the second spacers 322 is in a range between about 15-20 microns such that the length difference (b-c) ranges from about 10 microns to about 20 microns. It is also preferable that the bottom areas of the first and the second spacers 321 and 322 are in a range between about 600-1,100 square microns and in a range between about 150-350 square microns, respectively.

Since the first spacers 321 exhibit small compression deformation and are advantageous for dispersing the stress, they are capable of keeping a cell gap between the two

panels 100 and 200 uniform. On the contrary, since the second spacers 322 exhibit large compression deformation, they facilitate to adjust an amount of LC for forming the liquid crystal layer 3.

Here, the first and the second spacers 321 and 322 are formed through the photolithography using one mask or two masks, and will be described with the reference of the drawings.

Figs. 4A and 4B are sectional views of a LC panel assembly in intermediate steps of a manufacturing method thereof according to a first embodiment of the present invention, Figs. 5A and 5B are sectional views of a panel assembly for the display device in intermediate steps of a manufacturing method thereof according to a second embodiment of the present invention, and Fig. 6 is a sectional view of a panel assembly for the display device in an intermediate step of a manufacturing method thereof according to a third embodiment of the present invention. The first and the third embodiments use one mask, and the second embodiment uses two mask.

Referring to Fig. 4A, a negative acrylic photoresist 59 is coated on a panel 100 for an LCD in the first embodiment. An exposure mask 60 including an opaque film 61 having a plurality of openings 62 with a length e is disposed on the panel 100 with a distance d. The exposure mask 60 is aligned such that the openings 62 face portions of the photoresist 59 to become the second spacers 322 shown in Fig. 3. The photoresist 59 is then exposed to light from a light source through the exposure mask 60 so that the portions of the photoresist 59 exposed to light be hardened.

Referring to Fig. 4B, the exposure mask 60 is moved in horizontal and vertical directions such that it is spaced apart from the panel 100 by a distance ($d+\alpha$), where α is positive, and the openings 62 face portions of the photoresist 59 to become the first spacers 321 shown in Fig. 3. The photoresist 590 suffers light exposure through the exposure mask 60. Since the distance ($d+\alpha$) is larger than the distance d, the exposed portions of the photoresist 59 in this step have larger areas than those in the previous step due to the diffraction of light, and in addition, the intensity of the light reaching the photoresist 400 in this step is weaker than that in the previous step.' Accordingly, the first spacers 321 become wider and shorter than the second spacers 322.

An experiment was successfully performed under the condition that a light source with luminance of 100-300 mJ/cm² was used, the diameter of the openings 62 was 10-15

microns, the distance d between the exposure mask 60 and the panel 100 was 100-200 microns, and the distance ($d+\alpha$) was 300-400 microns.

In the second embodiment, the step shown in Fig. 5A is similar to the step shown in the first embodiment. That is, after a negative acrylic photoresist 59 is coated on a LC panel 100, an exposure mask 60 including an opaque film 61 having a plurality of openings 62 with a length e is disposed on the panel 100 with a distance d and the photoresist 59 is then exposed to light from a light source through the exposure mask 60 so that portions of the photoresist 59 exposed to light are hardened to be the second spacers 322.

Referring to Fig. 5B, another exposure mask 65 including an opaque film 66 having a plurality of openings 67 with a length $e+\beta$, where β is positive, is disposed on the panel 100 such that the openings 67 face portions of the photoresist 59 to become the first spacers 321 shown in Fig. 3. The photoresist 59 is exposed to light from another light source with a luminance weaker than that of the light source used in the previous step.

Referring to Fig. 6, after a negative acrylic photoresist 59 is coated on a LC panel 100 in the third embodiment, an exposure mask 70 having a plurality of transparent areas, a plurality of translucent areas, and an opaque area is disposed on the panel 100 with a distance. The opaque area and the translucent areas include an opaque film 71 and a plurality of translucent films 73, respectively, while the transparent areas have a plurality of openings 72. The exposure mask 70 is aligned such that the openings 72 and the translucent films 73 face portions of the photoresist 59 to become the second spacers 322 and the first spacers 321 shown in Fig. 3, respectively. The photoresist 59 is then exposed to light from a light source through the exposure mask 70.

The spacers 321 and 322 may be made from a positive photoresist, and in this case, the opaque areas and the transparent areas shown in Figs. 4A-6 are reversed.

The panel 100 may be a thin film transistor (TFT) array panel provided with a plurality of gate lines and a plurality of data lines for transmitting electrical signals such as scanning signals and data signals, a plurality of TFTs electrically connected to the gate lines and the data lines for controlling the data signals, and a plurality of pixel electrodes receiving the data voltages for driving the LC molecules.

The panels 100 may be provided with a common electrode facing the above-described pixel electrodes to generate electric fields for driving the LC molecules, and a plurality of color filters of red R, green G and blue B for color display.

The color filters or the common electrode may be formed on the TFT array panel.

An exemplary LC panel assembly according to an embodiment of the present invention will be described in more detail with reference to Figs. 7-10.

Fig. 7 is a layout view of an LCD according to a first embodiment of the present invention, Fig. 8 is an exemplary sectional view of the LCD shown in Fig. 7 taken along the line VIII-VIII', Fig. 9 is an exemplary sectional view of the LCD according to a second embodiment of the present invention, and Fig. 10 shows exemplary locations of the spacers in the display device according to an embodiment of the present invention.

The TFT array panel 100 is now described in detail.

A plurality of gate wires for transmitting gate signals and a plurality of storage electrode lines 131, which are made of conductive material having low resistance, are formed with tapered structure on an insulating substrate 110.

The gate wires include the gate lines 121, an end portion 129 connected to the gate lines 121 and applying scanning signal from the external to the gate lines 121 and a gate electrode 124 connected to the gate lines 121. But, the storage electrode lines 131 are added, the gate lines 121 may be extend to overlap the pixel electrode 190 such that expended potion of the gate lines 121 may make the storage capacitor along with the pixel electrode 190.

A gate insulating layer 140 preferably made of silicon nitride (SiNx) is formed on the gate wires 121 and the storage electrode lines 131.

A plurality of semiconductor islands 150 preferably made of hydrogenated amorphous silicon (abbreviated as "a-Si") are formed on the gate insulating layer 140. The semiconductor islands 150 are located opposite the respective gate electrodes 124.

A plurality of ohmic contact islands 163 and 165 preferably made of silicide or n+ hydrogenated a-Si heavily doped with n type impurity are formed on the semiconductor islands 150.

A plurality of data wires separated from each other and having conductive material of low resistance are formed on the ohmic contacts 163 and 165 and the gate insulating layer 140.

The data wires include a plurality of data lines 171 for transmitting data voltages extend substantially in the longitudinal direction and intersect the gate lines 121 and the storage electrode lines 131, a plurality of source electrode 173 toward the ohmic contact islands 163, a plurality of drain electrode 175 in a pair are separated from each other and opposite each other with respect to a gate electrode 124, and a plurality of end portions 179 connected to the data lines 171 and receiving the image signal form the external. The data wires further may include a plurality of storage conductor connected to the pixel electrode 190 and overlapping the storage electrode lines 131 to improve the storage capacitance.

A passivation layer 180 is formed on the data lines 171 and exposed portions of the semiconductor islands 150, which are not covered with the data lines 171 and the drain electrodes 175. The passivation layer 180 may have a double-layered structure including a lower inorganic film and an upper organic film for preventing direct contact between the semiconductor islands 150 and an organic film.

The passivation layer 180 has a plurality of contact holes 182 and 185 exposing end portions 179 of the data lines 171 and the drain electrodes 175, respectively. The passivation layer 180 and the gate insulating layer 140 have a plurality of contact holes 181 exposing end portions 129 of the gate lines 121.

A plurality of pixel electrodes 190 and a plurality of contact assistants 81 and 82, which are preferably made of ITO, IZO, are formed on the passivation layer 180.

The pixel electrodes 190 are physically and electrically connected to the drain electrodes 175 through the contact holes 185 such that the pixel electrodes 190 receive the data voltages from the drain electrodes 175.

The contact assistants 81 and 82 are connected to the end portion 129 of the gate lines 121 and the end portion 179 of the data lines 171 through the contact holes 182 and 181, respectively.

Portions of the passivation layer 180 near the contact assistants 81 and 82 may be completely removed, and such a removal is particularly advantageous for a chip-on-glass type LCD.

The description of the color filter panel 200 follows.

A black matrix 220 for preventing light leakage is formed on an insulating substrate 210 such as transparent glass and the black matrix 220 includes a plurality of openings facing the pixel regions and having substantially the same shape as the pixel electrodes 190.

A plurality of red, green and blue color filters 230 are formed substantially in the openings of the black matrix 220.

A common electrode 270 preferably made of transparent conductive material such as ITO and IZO is formed on the color filters 230 and the black matrix 220. The common electrode 270 covers entire surface of the panel 200.

A liquid crystal layer 3 is formed between the two panels, and a plurality of spacers 402 are formed between two panels 100 and 200 to support two panels 100 and 200 with the uniform interval. Although the second spacers 322 are showed, the first spacers (referring to Fig. 2) are actually formed.

The LCD may be a twisted nematic (TN) mode LCD where liquid crystal molecules in the liquid crystal layer 3 having positive dielectric anisotropy are aligned parallel to surfaces of the panels 100 and 200 and the molecular orientations are twisted from the surface of one of the panels 100 and 200 to the surface of the other of the panels 100 and 200 in absence of electric field. Alternatively, the LCD is a vertically aligned (VA) mode LCD, that is, the liquid crystal molecules in the liquid crystal layer 3 with negative dielectric anisotropy are aligned vertical to surfaces of the panels 100 and 200 in absence of electric field. Alternatively, the LCD is an optically compensated bend (OCB) mode LCD, where the liquid crystal molecules have a bend alignment symmetrical with respect to a mid-plane between the panels 100 and 200 in absence of electric field.

Although the spacers 322 are formed on the thin film transistor array panel 100 in the first embodiment, may be formed on the color filter panel 200.

Although Figs. 7-9 show the spacers 322 located on the data lines 171, the spacers 322 can be located on the gate lines 121, the TFTs, or any places covered by the black matrix 220.

Referring to Fig. 10, a plurality of red, green and blue color filters R, G and B are arranged in a stripe type. The spacers 321 and 322 are arranged in a regular or periodic manner along a row direction and a column direction. For example, the spacers 321 and 322 are located between the blue filters B and the red filters R and spaced apart from each other by predetermined transverse and longitudinal distances as shown in Fig. 10. The concentration of

the first spacers 321 is preferably in a range of about 200-600/cm^2, while that of the second spacers 322 is preferably in a range of about 250-450/cm^2.

A method of manufacturing a panel assembly for an LCD according to the first embodiment of the present invention is now described in detail.

At first, a plurality of gate lines, a plurality of data lines, a plurality of TFTs, a plurality of pixel electrodes made of transparent or reflective material and the like are formed on an insulating substrate 110 to form a TFT array panel 100. An organic insulating material is deposited on the panel 100 and patterned by photolithography to form a plurality of spacers 321 and 322 between the pixel areas. Meanwhile, a black matrix, a plurality of red, green and blue color filters, a common electrode, and so on are formed on another substrate 210 to form a color filter panel 200. It is preferable that the size of the spacers 321 and 322 is equal to about 110-130% of the distance between the panels 100 and 200. The formation of the spacers 321 and 322 using photolithography enables to uniformly arrange the spacers 321 and 322 such that a thin uniform cell gap can be obtained throughout the panels 100 and 200 and the spacers 321 and 322 are prevented from being placed on the pixel regions, thereby improving the display characteristics.

Thereafter, a sealant 310 is coated on one of the panels 100 and 200 having the spacers 321 and 322. The sealant 310 has a shape of a closed loop without an injection hole for injecting LC. The sealant 310 may be made of thermosetting material or ultraviolet-hardening material and may contain a plurality of spacers for keeping the gap between the panels 100 and 200. Since the sealant 310 has no injection hole, it is important to exactly control the amount of the LC material. In order to solve any problem due to the excessive amount of the LC or the insufficient amount of the LC, a buffer region without LC material even after the termination of the panel combination is preferably provided at the sealant 310. Meanwhile, it is preferable that the sealant 310 has an anti-reaction film on its surface, which is not reactant with the LC layer 3.

A LC material is coated or dropped using a LC coater on the one of the panels 100 and 200 coated with the sealant 310. The LC coater may have a dice shape such that it can drop the LC material at the LC device areas 51-54. The LC may be sprayed on the entire surface of the LC device areas 51-54. In this case, the LC coater has a shape of a sprayer.

The panels 100 and 200 are delivered to an assembly device with a vacuum chamber. The room surrounded by the panels 100 and 200 and the sealant 310 is evacuated and the panels 100 and 200 are closely adhered to each other using atmospheric pressure such that the distance between the panels 100 and 200 reaches a desired cell gap. The sealant 310 is completely hardened with the illumination of an ultra-violet (UV) ray using a light exposer. In this way, the two panels 100 and 200 are assembled to form a liquid crystal panel 40. The two panels 100 and 200 are exactly aligned to a minute order during the step of adhering the panels 100 and 200 and the step of illuminating UV ray on the sealant 310.

Finally, the liquid crystal panel 40 is separated into the LC device areas 51-54 using a scribing machine.

A panel assembly for LCDs according to a fourth embodiment of the present invention will be now described in detail with reference to Figs. 11 and 12.

Fig. 11 is a plan view of a panel assembly for LCDs according to a fourth embodiment of the present invention and Fig. 12 is a sectional view of the panel assembly shown in Fig. 11 taken along the line XII-XII'.

As shown in Figs. 11 and 12, a panel assembly 40 according to a fourth embodiment of the present invention includes two panels 100 and 200 and a plurality of LC layers 3, a plurality of sealants 310, and a plurality of columnar spacers 321 and 322, which are disposed between the two panels 100 and 200.

The panel assembly 40 includes a plurality of, for example, four device areas divided by dotted lines A and B. The panel assembly 40 is separated into the respective LCDs by scribing the panel assembly 40 along the dotted lines A and B.

Each of the device areas (or an LCD) includes a display area 51, 52, 53 or 54 for displaying images. The display area 51 is substantially enclosed by the sealant 310, which confines the LC layer 3. The LC layer 3 may be formed after the panel assembly 40 is separated into the respective devices. The sealant 310 may contain spacers for supporting the panels 100 and 200 to be parallel to each other.

The panel 200 includes an insulating substrate 210, a black matrix 220 formed on the substrate 210, a plurality of color filters 230 formed on the black matrix 220 and the substrate 210, and a common electrode (not shown) formed thereon. The color filters 230 include a plurality of red filters 230R, a plurality of green filters 230G, and a plurality of blue filters 230B.

The blue filters 230B, the green filters 230G, and the red filters 230R are sequentially arranged in a transverse direction and have decreasing thicknesses as shown in Fig. 12.

As shown in Fig. 12, the spacers 320 for maintaining a gap between the panels 100 and 200 to be uniform includes a plurality of first, second, and third spacers 321-323 formed on the blue filters 230B, the green filters 230G, and the red filters 230R, respectively, and contacting the panels 100 and 200 with different contact areas. The different contact areas of the spacers 320 are obtained by forming spacer columns having the same thickness but having different top heights due to the different thickness of the color filters 230 and by pressing the spacer columns such that the top surfaces of the spacer columns have the same height.

Fig. 13 is a sectional view of a panel and a plurality of column spacers according to the fourth embodiment of the present invention, and Fig. 14 shows exemplary locations of the spacers according to the fourth embodiment of the present invention.

A plurality of first, second, and third column spacers 321-323 having the same height are formed on the blue filters 230B, the green filters 230G, and the red filters 230R, respectively. The heights of top surfaces of the first to the third spacers 321-323 are different due to the different thickness of the color filters 230B, 230G, 230R as shown in Fig. 13. The thickness of the green filters 230G and the red filters 230R may be equal to equalizing the top heights of the second and the third spacers 322 and 323.

The first spacers 321, which are primary spacers, keep a cell gap between the two panels 100 and 200 uniform during a normal operation. The second and the third spacers 322 and 323 prevent the excessive reduction of the cell gap due to an external pressure.

The different contact areas of the spacers 321-323 are also obtained by forming spacer columns having different thicknesses with or without the different thicknesses of the color filters 230 and by pressing the spacer columns such that the top surfaces of the spacer columns have the same height.

Referring to Fig. 14, a plurality of red, green and blue color filters R, G and B are arranged in a stripe type. Three kinds of spacers 320 are arranged in a regular or periodic manner along a row direction and a column direction. For example, the different kinds of the spacers 320 are located between the color filters having different colors and spaced apart from each other by predetermined transverse and longitudinal distances as shown in Fig. 14.

Although the spacers 320 are located on the data lines 171, the spacers 320 can be located on the gate lines 121, the TFTs, or any places covered by the black matrix 220 and a plurality of red, green and blue color filters 230.

Furthermore, it is preferable that the spacers 320 are arranged in a regular or periodic manner between the same pixels. For example, the first to the third spacers 321, 322 and 323 are located between the blue pixels R, G, B and spaced apart from each other by predetermined transverse and longitudinal distances in a regular or periodic manner as shown in Fig. 10 according to the fourth embodiment.

A LCD according to a fourth embodiment of the present invention will be now described in detail with reference to the drawings.

Fig. 15 is a layout view of an LCD according to the fourth embodiment of the present invention, and Figs. 16 and 17 are sectional views of the LCD shown in Fig. 16 taken along the line XVI-XVI' and the line XVII-XVII', respectively.

The TFT array panel 100 is now described in detail.

A plurality of gate wires for transmitting gate signals and a plurality of storage electrode lines 131, which are made of conductive material having low resistance, are formed with tapered structure on an insulating substrate 110.

The gate wires include the gate lines 121, an end portion 129 connected to the gate lines 121 and extended with wide width to apply scanning signal from the external to the gate lines 121 and a gate electrode 124 connected to the gate lines 121. But, the storage electrode lines 131 are added, the gate lines 121 may be extended to overlap the pixel electrode 190 such that expended potion of the gate lines 121 may make the storage capacitor along with the pixel electrode 190.

A gate insulating layer 140 preferably made of silicon nitride (SiNx) is formed on the gate wires 121 and the storage electrode lines 131.

A plurality of semiconductor islands 150 preferably made of hydrogenated amorphous silicon (abbreviated as "a-Si") are formed on the gate insulating layer 140. The semiconductor islands 150 are located opposite the respective gate electrodes 124.

A plurality of ohmic contact islands 163 and 165 preferably made of silicide or n+ hydrogenated a-Si heavily doped with n type impurity are formed on the semiconductor islands 150.

A plurality of data wires separated from each other and having conductive material of low resistance are formed on the ohmic contacts 163 and 165 and the gate insulating layer 140.

The data wires include a plurality of data lines 171 for transmitting data voltages extend substantially in the longitudinal direction and intersect the gate lines 121 and the storage electrode lines 131, a plurality of source electrode 173 toward the ohmic contact islands 163, a plurality of drain electrode 175 in a pair are separated from each other and opposite each other with respect to a gate electrode 123, and a plurality of end portions 179 connected to the data lines 171 and receiving the image signal form the external. The data wires further may include a plurality of storage conductor connected to the pixel electrode 190 and overlapping the storage electrode lines 131 to improve the storage capacitance.

A passivation layer 180 is formed on the data lines 171 and exposed portions of the semiconductor islands 150, which are not covered with the data lines 171 and the drain electrodes 175. The passivation layer 180 is preferably made of photosensitive organic material having a good flatness characteristic, low dielectric insulating material such as a-Si:C:O:H formed by plasma enhanced chemical vapor deposition (PECVD). The passivation layer 180 may have a double-layered structure including a lower inorganic film and an upper organic film for preventing direct contact between the semiconductor islands 150 and an organic film.

The passivation layer 180 has a plurality of contact holes 182 and 185 exposing end portions 179 of the data lines 171 and the drain electrodes 175, respectively. The passivation layer 180 and the gate insulating layer 140 have a plurality of contact holes 181 exposing end portions 129 of the gate lines 121.

A plurality of pixel electrodes 190 and a plurality of contact assistants 81 and 82, which are preferably made of ITO, IZO, are formed on the passivation layer 180.

The pixel electrodes 190 are physically and electrically connected to the drain electrodes 175 through the contact holes 185 such that the pixel electrodes 190 receive the data voltages from the drain electrodes 175.

The contact assistants 81 and 82 are connected to the end portion 129 of the gate lines 121 and the end portion 179 of the data lines 171 through the contact holes 182 and 181, respectively.

The description of the color filter panel 200 follows.

A black matrix 220 for preventing light leakage is formed on an insulating substrate 210 such as transparent glass and the black matrix 220 includes a plurality of openings facing the pixel regions and having substantially the same shape as the pixel electrodes 190.

A plurality of red R, green G and blue B color filters 230 are formed substantially in the openings of the black matrix 220.

A common electrode 270 preferably made of transparent conductive material such as ITO and IZO is formed on the color filters 230 and the black matrix 220. The common electrode 270 covers entire surface of the panel 200.

A liquid crystal layer 3 is formed between the two panels, and a plurality of spacers 320 are formed between two panels 100 and 200 to support two panels 100 and 200 with the uniform interval.

The LCD may be a twisted nematic (TN) mode LCD where liquid crystal molecules in the liquid crystal layer 3 having positive dielectric anisotropy are aligned parallel to surfaces of the panels 100 and 200 and the molecular orientations are twisted from the surface of one of the panels 100 and 200 to the surface of the other of the panels 100 and 200 in absence of electric field. Alternatively, the LCD is a vertically aligned (VA) mode LCD, that is, the liquid crystal molecules in the liquid crystal layer 3 with negative dielectric anisotropy are aligned vertical to surfaces of the panels 100 and 200 in absence of electric field. Alternatively, the LCD is an optically compensated bend (OCB) mode LCD, where the liquid crystal molecules have a bend alignment symmetrical with respect to a mid-plane between the panels 100 and 200 in absence of electric field.

On the other hand, the first, second, and third column spacers 321-323 having the same height are formed on the blue filters 230B, the green filters 230G, and the red filters 230R having the first to the third spacers 321-323 as above described. But, the the first, second, and third column spacers having different heights may be formed, and will be described in detail.

Fig. 18 is a sectional view of a LC panel assembly in an intermediate step of a manufacturing method thereof according to the fifth embodiment of the present invention, and Fig. 19 is a sectional view of a LC panel assembly in an intermediate step of a manufacturing method thereof according to a sixth embodiment of the present invention.

At first, a fifth embodiment will be described.

Referring to Fig. 15, a negative acrylic photoresist 59 is coated on a LC panel 200 having a plurality of red, green and blue color filters 230. An exposure mask 60 including an opaque film 61 having a plurality of openings 62 and a plurality of slit areas 64 are disposed on the panel 200. The slit areas 64 includes a plurality of slits and may have at least two slit areas with different slit widths and different slit distances. The exposure mask 60 is aligned such that the openings 62 face portions of the photoresist 59 to become the tallest spacers 321 and the slit areas 64 face portions of the photoresist 59 to become other spacers 322 and 323. The photoresist 59 is then exposed to light from a light source through the exposure mask 60 so that the portions of the photoresist 59 exposed to light be hardened. A portion facing a slit area 64 having smaller slit width and smaller slit distance becomes a shorter spacer.

Now, a sixth embodiment will be described.

Referring to Fig. 16, after a negative acrylic photoresist 59 is coated on a LC panel 200 having a plurality of red, green and blue color filters 230, an exposure mask 70 having a plurality of transparent areas 72, a plurality of translucent areas 73, and an opaque area 71 is disposed on the panel 200. The opaque area 71 and each translucent area 73 include an opaque film and a translucent film, respectively, while each transparent area 72 has an opening. The translucent areas 73 may include at least two translucent areas having different transmittances. The exposure mask 70 is aligned such that the transparent areas 72 and the translucent areas 73 face portions of the photoresist 59 to become the tallest spacers 321 and the remaining spacers 322 and 323, respectively. The photoresist 59 is then exposed to light from a light source through the exposure mask 70. A portion facing a translucent area 73 having smaller transmittance becomes a shorter spacer.

The panel 200 may be a thin film transistor (TFT) array panel provided with a plurality of gate lines and a plurality of data lines for transmitting electrical signals such as scanning signals and data signals, a plurality of TFTs electrically connected to the gate lines and the data lines for controlling the data signals, and a plurality of pixel electrodes receiving the data voltages for driving the LC molecules.

The panels 200 may be provided with a common electrode facing the above-described pixel electrodes to generate electric fields for driving the LC molecules, and a plurality of color filters of red R, green G and blue B for color display.

The color filters or the common electrode may be formed on the TFT array panel.

A method of manufacturing a panel assembly for an LCD according to the first embodiment of the present invention is now described in detail.

At first, a common electrode, blue, green and red color filters, and a black matrix are formed on a panel 200. An organic insulating material is deposited on the panel 200 and patterned by photolithography to form a plurality of spacers 320 overlapping the blue, green and red color filters and the black matrix between the pixel areas. and a plurality of column spacers 320. Meanwhile, a plurality of gate lines, a plurality of data lines, a plurality of TFTs, a plurality of pixel electrodes made of transparent or reflective material and the like are formed on an another panel. The color filters or the common electrode may be formed on the same panel having the thin film transistors. It is preferable that the size of the spacers 320 is equal to about 110-130% of the distance between the panels 100 and 200. The formation of the spacers 320 using photolithography enables to uniformly arrange the spacers 320 such that a thin uniform cell gap can be obtained throughout the panels 100 and 200 and the spacers 320 are prevented from being placed on the pixel regions, thereby improving the display characteristics.

Thereafter, a sealant 310 is coated on one of the panels 100 and 200 having the spacers 321 and 322. The sealant 310 has a shape of a closed loop without an injection hole for injecting LC. The sealant 310 may be made of thermosetting material or ultraviolet-hardening material and may contain a plurality of spacers for keeping the gap between the panels 100 and 200. Since the sealant 310 has no injection hole, it is important to exactly control the amount of the LC material. In order to solve any problem due to the excessive amount of the LC or the insufficient amount of the LC, a buffer region without LC material even after the termination of the panel combination is preferably provided at the sealant 310. Meanwhile, it is preferable that the sealant 310 has an anti-reaction film on its surface, which is not reactant with the LC layer 3.

A LC material is coated or dropped using a LC coater on the one of the panels 100 and 200 coated with the sealant 310. The LC coater may have a dice shape such that it can drop the LC material at the LC device areas 51-54. The LC may be sprayed on the entire surface of the LC device areas 51-54. In this case, the LC coater has a shape of a sprayer.

The panels 100 and 200 are delivered to an assembly device with a vacuum chamber. The room surrounded by the panels 100 and 200 and the sealant 310 is evacuated and the panels 100 and 200 are closely adhered to each other using atmospheric pressure such that the distance

between the panels 100 and 200 reaches a desired cell gap. The sealant 310 is completely hardened with the illumination of an ultra-violet (UV) ray using a light exposer. In this way, the two panels 100 and 200 are assembled to form a liquid crystal panel 40. The two panels 100 and 200 are exactly aligned to a minute order during the step of adhering the panels 100 and 200 and the step of illuminating UV ray on the sealant 310.

Finally, the liquid crystal panel 40 is separated into the LC device areas 51-54 using a scribing machine.

[ADVANTAGE OF THE INVENTION]

As described above, the spacers have at least two different heights or at least two different contact areas with the panel in the present invention. Accordingly, a cell gap between the two panels may be uniform, and may adjust an amount of LC for forming the liquid crystal layer. Also, the density of spacers may be minimized such that light leakage may be prevented.

[CLAIMS]

1. A panel for a display device, the panel assembly comprising:

a panel; and

a plurality of spacers formed on the panel for supporting the panel,

wherein the spacers have at least two different heights.

2. The panel of claim 1, wherein the spacers comprise a first spacer, a second spacer having a height lower than the first spacer, and a third spacer having a height equal to or lower than the second spacer.

3. The panel of claim 2, wherein the height of the third spacer is equal to the height of the second spacer.

4. The panel of claim 1, wherein the panel has a plurality of red, green and blue color filters with sequential arrangement.

5. A liquid crystal display, comprising:

the first panel of claim 1;

a thin film transistor panel including a pixel electrode facing the common electrode and arranged in the pixel region, and a gate line and a data line defining the pixel region; and

a liquid crystal layer filled between the panel and the thin firm transistor panel.

6. A method of manufacturing a panel for a display device, the method comprising:

coating a photoresist on a panel;

light-exposing the photoresist through an exposure mask including a plurality of transmissive areas having different transmittances and a blocking area; and

developing the photoresist to form a plurality of spacers having different heights.

7. A method of manufacturing a panel for a display device, the method comprising:

coating a photoresist on a panel;

light-exposing the photoresist through an exposure mask including a plurality of silt pattern to control different transmittances; and

developing the photoresist to form a plurality of spacers having different heights.

[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

A plurality of spacers is formed on a panel for a liquid crystal display for supporting the panel. The spacers have at least two different heights or at least two different contact areas with the panel. The spacers include a plurality of first spacers and a plurality of second spacers having a height lower than the first spacers and having a contact area wider than the first spacers. The height difference between the first spacers and the second spacers is preferably in a range of about 0.3-0.6 microns, and the second spacers have a length larger than the first spacers preferably by 10-20 microns. Since the first spacers exhibit small compression deformation and are advantageous for dispersing the stress, they are capable of keeping a cell gap between the two panels uniform. On the contrary, since the second spacers exhibit large compression deformation, they facilitate to adjust an amount of LC for forming the liquid crystal layer and prevent light leakage phenomenon.

[REPRESENTATIVE FIGURE]

Fig. 13

[INDEX]

liquid crystal, spacer, liquid crystal panel, liquid crystal cell gap